Highlights from Recent Literature

1 Analytical

1.1 Application of Energy-Dispersive X-Ray Fluorescence to Jewelery Samples Determining Gold and Silver

The results from a study of the real scope of energy-dispersive x-ray fluorescence Analysis in an Assay Office, in which precious metal samples must be analyzed prior to their hallmarking according to Spanish regulations, are presented. A Jurado-Lopez, M Luque de Castro, R Perez-Morales from the Analytical Chemistry Department, University of Cordoba, Spain SO *Gold Bulletin* 2006, **39(1)**, 16. The advantages and limitations of this technique for the Analysis of Au and Ag jewelery samples, which is one of the most significant industrial activities in the local area (Cordoba, Spain), are reported. The results of Au and Ag support the use of this technique in Assay Offices, not only for screening purposes, but also as an alternative to cupellation and potentiometric titrn. for a number of samples. The application of the energy-dispersive x-ray fluorescence spectrometer for the detection of plating layers like Rh and Ni is also discussed.

1.2 Magic Gold Nanotubes

In recent ultra-high-vacuum TEM experiments evidence is found for the formation of suspended Au single-wall nanotubes (SWNTs) composed of 5 helical strands. R Senger, D Tugrul, S Ciraci from the Department of Physics, Bilkent University, Ankara, 06800, Turkey, *Turkish Journal of Physics* 2005, **29(5)**, 269. Similar to C nanotubes, the (n,m) notation defines the structure of the Au SWNTs. Experimental, only the (5,3) tube forms among several other possible alternatives. Using 1st-principles calculations Au atoms can form both freestanding and tip-suspended, chiral, single-wall nanotubes. Although freestanding, infinite (5,5) tube is energetically the most favorable, the experimental observed (5,3) tube, suspended between 2 tips, corresponds to a local min. in the variation of string-tension with the radius of the structure, which explains the experimental finding. Similarly, the authors predict the (4,3) tube as a favorable structure yet to be observed experimental Analysis of band structure, charge d., and quantum ballistic conductance suggests that the current on these nanowires is less chiral than expected, and there is no direct correlation between the nos. of conduction channels and helical strands.

2 Catalysis

2.1 Cyclic voltammetry as a potential predictive method for supported nanocrystalline gold catalysts for oxidation in aqueous media

Nanocryst. supported Au is a potent catalyst for oxidation of alcs. and polyols in aqueous media using O in which exclusive formation of the mono-acid can be observed. G Hutchings, S Carrettin, P McMorn, P Jenkins, G Attard, P Johnston, K Griffin, C Kiely from the CS School of Chemistry, Cardiff University, UK, *ACS Symposium Series* 2006, **921**(Feedstocks for the Future), 82. However, relatively nonselective catalysts for the same reaction can also be prepd. Herein the authors present a detailed characterization study of wholly selective and nonselective Au/graphite catalysts used in the oxidation of glycerol to glyceric acid using a combination of cyclic voltammetry (CV) and TEM. Analysis using TEM, a technique that is often incisive with supported Au catalysts, in this particular case shows that the nonselective catalysts comprise relatively larger Au crystallites as compared to those of the more selective catalysts. A set of three Au/C with different selectivities for glyceric acid were characterized using TEM but no discernable differences were observed which could be correlated with the selectivity differences. A detailed study using CV shows distinct differences between the four catalysts. In particular, differences in the activity and selectivity of these Au/graphite catalysts towards glycerol oxidation can be correlated to differences in the relative rates of formation of the selective O species and surface poisons as detected using cyclic voltammetry. Probably these cyclic voltammetry correlations can have predictive potential for supported Au catalysts.

2.2 Role of gold cations in the oxidation of carbon monoxide catalyzed by iron oxide-supported gold

Recent intense interest in catalysis by supported gold has focused mainly on the oxidation of CO at low temperatures, which offers the potential for many important applications, including the purifn. of hydrogen for automotive fuel cells. G Hutchings, M Hall, A Carley, P Landon, B Solsona, C Kiely, A Herzing, M Makkee, J Moulijn, A Overweg, JC Fierro-Gonzalez, J Guzman, B Gates, from the School of Chemistry, Cardiff University, UK *Journal of Catalysis* 2006, **242(1)**, 71. Numerous, contradictory proposals have been made concerning the nature of the active sites in supported gold catalysts. We now present evidence from a set of complementary experimental methods characterizing Au/.alpha.-Fe_2O_3 catalysts, demonstrating that cationic gold plays a crucial role in catalyzing CO oxidation at 298 K, as well as in the hydrogenation of crotonaldehyde. A series of catalysts based on a co-precipitation. 5-wt% Au/Fe_2O_3 precursor heat treated in different ways were compared for CO oxidation at ambient temperature. The catalysts were structurally and chem. analyzed by HREM and STEM-XEDS. A combination of EXAFS, in situ XANES, XPS, and Mossbauer

effect spectroscopy demonstrates the important role of cationic gold in the activity of these iron oxide-supported gold catalysts.

2.3 An Overview of Gold-Catalysed Oxidation Processes

A review; gold and gold/platinum group metals (Au/PGM) catalysts are active under mild conditions or even at ambient temperature or less and this makes them unique. They will therefore be effective in reducing running costs of chem. plants and increasing the selectivity of the reactions involved where applicable. D Thompson, Consultant to World Gold Council and Project AuTEK, World Gold Council, London, UK *Topics in Catalysis* 2006, **38(4)**, 231. In pollution control applications such as air cleaning, low light-off autocatalysts, and purifn. of hydrogen streams used for fuel cells they have the characteristics to become the catalysts of choice, especially now that their durability and resistance to poisons is being shown to be better than was anticipated. The mechanisms of these gold catalyzed reactions are still uncertain but both oxidised and metallic gold are probably involved, and the details depend on types of reaction and the conditions used.

3 Chemistry

3.1 Theoretical Insights on O_2 and CO Adsorption on Neutral and Positively Charged Gold Clusters

With the aim of understanding the elementary steps governing the oxidation of CO catalyzed by dispersed or supported gold nanoclusters, the adsorption of mol. species, such as O_2 and CO, on model neutral and pos. charged clusters (Aunm+ n = 1, 9, and 13; m = 0, 1, and 3) has been studied using an ab initio approach. A Prestianni, A Martorana, F Labat, I Ciofini, C Adamo, from the Dipartimento di Chimica Inorganica e Analitica, Universita di Palermo, Italy, *Journal of Physical Chemistry B* 2006, **110(25)**, 12240. The computed structural and thermodn. data related to the binding process show that mol. oxygen interacts better with neutral clusters, acting as an electron acceptor, while CO more strongly binds to pos. charged species, thus acting as an electron donor.

3.2 Nano-Jewellery: C_5Au_{12}-a Gold-Plated Diamond at Molecular Level

A mixed carbon-metal cluster is designed by combining the tetrahedral C_5 radical (with a central atom-the skeleton of the C_5H_{12} mol.) and the spherical Au_{12} layer (the external at. shell of the Au_{13} cluster). F Naumkin, from the Faculty of Science, University of Ontario Institute of Technology, Oshawa, Canada, *Physical Chemistry Chemical Physics* 2006, **8(21)**, 2539. The C_5Au_{12} cluster and its neg. and pos. ionic derivs., C_5Au_{12}.+-., are investigated ab initio (DFT) in terms of optimized structures and relative energies of a few spin-states, for the icosahedral-like and octahedral-like isomers. The cluster is predicted to be generally more stable in its octahedral shape (similar to C_5H_{12}) which prevails for the neg. ion and may compete with the icosahedral shape for the neutral system and pos. ion. Adiabatic ionization energies (AIE) and electron affinities (AEA) of C_5Au_{12}, vertical electron-detachment (VDE) energies of C_5Au_{12}-., and vertical ionization and electron-attachment energies (VIE, VEA) of C_5Au_{12} are calculated as well, and compared with those for the corresponding isomers of the Au_{13} cluster. The AIE and VIE values are found to be close for the two systems, while the AEA and VDE values are significantly reduced for the radical-based species. A simple fragment-based model is proposed for the decomposition of the total interaction into carbon-gold and gold-gold components.

3.3 Radical Trapping by Gold Chlorides Forming Organogold Intermediates

Organogold compds. arising from the trapping of carbon-centered radicals by gold chlorides (AuCl, $AuCl_3$, and $HAuCl_4$) and colloidal gold have been characterized by different spectroscopic techniques. C Aprile, M Boronat, B Ferrer, A Corma, H Garcia from the Instituto de Tecnologia Quimica and Departamento de Quimica, Universidad Politecnica de Valencia, Spain, *Journal of the American Chemical Society* 2006, **128(26)**, 8388. These organogold compds. are stable at room temperature in the presence of O_2. Laser flash photolysis has provided kinetic evidence of the occurrence of radical trapping in the microsecond time scale, while theor. calculations give the energetics of the elementary steps. The trapping of carbon radicals by gold species observed here may explain why the presence of radical initiators enhance dramatically the activity of gold catalysts for some reactions occurring through radical intermediates.

4 Electrochemistry

4.1 Electrochemical Surface Plasmon Resonance Measurement of Electrocatalytic Oxidation of Glucose on Gold Electrode

The electrochem. reaction of glucose on a thin Au film electrode was studied using the surface plasmon resonance (SPR) method. Y Iwasaki, O Niwa, from the NTT Microsystem Integration Laboratories, 3-1 Morinosato Wakamiya, Atsugi, Kanagawa, Japan, *Electrochemistry* Tokyo, Japan 2006, **74(2)**, 172. A cyclic voltammogram of glucose on a thin Au film electrode showed anodic current in both anodic and cathodic scans. The potential dependence of the refractive index change was simultaneously measured by SPR and showed that the change in the Au electrode surface status switched the catalytic reaction. A potential step experimenterate revealed that the SPR signal showed the underlying electrode status whereas the electrode current showed the overall catalytic oxidation of glucose.

4.2 Electrocatalytic Oxidation of Lactose on Gold Nanoparticle Modified Carbon in Carbonate Buffer

The electrocatalytic oxidation of lactose was studied on nanolength scale Au-colloids (5 nm) embedded in C felt as electrode (Au-NMC). K Kokoh, N Alonso-Vante, from the Laboratory of Electrocatalysis, Universite de Poitiers, Poitiers, France, *Journal of Applied Electrochemistry* 2006, **36(2)**, 147. A preliminary study by cyclic voltammetry, used to det. the optimized conditions of electrolysis, showed that the current densities were higher than those obtained on a gauze electrode of Au (Au-GE) with a surface area 3 times greater. Long-time electrolyzes were carried out using a 2 potential plateau program with different values for the oxidation potentials. Chromatog. and NMR analyses showed that the oxidation of lactose led mainly to lactobionate (91%).

5 Electronics and Sensors

5.1 Application of Gold-Tin Solder Paste for Fine Parts and Devices

Au-Sn solder paste can be applied by various providing methods, such as printing, dispense, pin transfer, etc. M Ishikawa, H Sasaki, S Ogawa, M Kohinata, A Mishima, H Yoshida from the Development Section, Sanda Plant, Advanced Products Strategic Company, Mitsubishi Materials Corporation, Japan, *Proceedings - Electronic Components & Technology Conference* 2005, **55th(Vol. 1)**, 701. These methods also make it possible to reduce the production cost. However, in the case of using solder paste, the occurrence of void is one of the most undesirable problems. In this study, we have tried to identify the mechanism of void generation and to reduce voids. We found that the most important factor was to prevent both the gases generated during the reflow process and the generation of Au and/or Sn rich phase in molten Au-Sn solder. For details, it was indicated that for the former it is practical to optimize the pre-heat temperature and holding time in reflow process, to make O_2 contents of the powder lower, to control the amt. of activator in flux, etc. For the latter it is important to optimize the composition of the Au-Sn alloy for the reduction of Au and/or Sn rich phases in molten solder.

5.2 Bimetallic Silver-Gold Film Waveguide Surface Plasmon Resonance Sensor

A waveguide surface plasmon resonance (SPR) optical sensor based on wavelength modulation is presented. B Ong, X Yuan, S Tjin, from the Photonic Research Centre, School of Electrical and Electronic Engineering, Nanyang Technological Univ., Singapore, Singapore, *Proceedings of SPIE-The International Society for Optical Engineering* 2006, **6123** (Integrated Optics: Devices, Materials, and Technologies X), 61230B/1. Strip waveguides are fabricated using MicroChem's SU-8 photoresist via UV lithog. Next, a bimetallic silver-gold film is deposited on the waveguides for exciting surface plasmon resonance. The underlying silver yields better evanescent field enhancement of the sensing surface, while the overlying gold ensures that the stability of the metallic film is not compromised. Experiments were conducted using various glucose concentrations as the analyte, and the normalized transmission output of the waveguide shows a good SPR curve for all the analytes. With a better evanescent field extension, the proposed waveguide SPR configuration extends the use of SPR, especially in bio-sensing, as longer ligands can be immobilized and bigger analytes can be monitored.

6 Medical and Dental

6.1 Method for Making Condom Containing Gold, Silver Or Magnetic Body and Condom Obtained Therefrom

A method for making a condom contg. gold, silver or a magnetic body is provided to prevent bacterial infections caused by sexual relationships and to impart effects favorable to the human body. J An, P Oh, from S. Korea Repub. Korean Kongkae Taeho Kongbo, PATENT KR 2004082236, A, Sept 2004. The method comprises: a mixing step in which purified latex, pulverized chems. and Ag- or Au-ionized water and stirring them gradually with a molding agent; an aging step in which the mixt. is compounded and then the compounded latex is aged at a suitable temperature to a degree suitable for molding; a molding step in which the aged latex is dipped in a condom-shaped glass mold and the latex attached on the mold surface is dried through a hot air drier to form a thin condom-shaped film and the resultant is repeatedly dipped and dried two times to form a more stable film, and a rim portion is formed; and a vulcanization step in which the molded product is dried with hot air to remove moisture completely and heated to obtain suitable phys. properties; a selection step in which defects in condoms are completely sorted out; and a packaging step in which a product passing the selection test is treated through a lubricant treating unit and an injection pump and then is packaged with rectangular- or square-shaped foil.

7 Metallurgy, Materials and Coatings

7.1 Evaluation of Gold Nanowire Pairs as a Potential Negative Index Material

A metamaterial consisting of pairs of metallic nanowires, sepd. by a dielec. spacer, was fabricated and spectrally characterized in the visible and near-IR spectral domain. F Garwe, C Rockstuhl, C Etrich, U Huebner, U Bauerschaefer, F Setzpfandt, M Augustin, T Pertsch, A Tuennermann, F Lederer from the Institute for Physical High Technology, Jena, Germany, *Applied Physics B: Lasers and Optics* 2006, **84(1-2)**, 139. The structure exhibits both a plasmonic and a magnetic resonance depending on its geometry and

orientation with respect to the illuminating wave field. In particular, we investigate the influence of the thickness of the spacer layer on the spectral position of the resonances and show that, for an appropriate adjustment, both resonances coincide. Measurements of the amplitude and the phase of the transmitted wave are presented. The material is highly anisotropic with respect to the angle of incidence, as the plasmonic resonance wavelength depends strongly on it whereas the magnetic resonance does not show this sensitivity. All experimental results are supported by numerical simulations.

7.2 Microstructure Evolution of Gold-Tin Eutectic Solder on Cu and Ni Substrates

The microstructures of the eutectic $Au_{20}Sn$ (%) solder that developed on the Cu and Ni substrates were studied. The Sn/Au/Ni sandwich structure (2.5/3.75/2 .mu.m) and the Sn/Au/Ni sandwich structure (1.83/2.74/5.8 .mu.m) were deposited on Si wafers first. J Tsai, C Chang, C Ho, Y Lin, C Kao, from the Department of Chemical & Materials Engineering, National Central University, Taiwan, *Journal of Electronic Materials* 2006, **35(1)**, 65. The overall composition of the Au and the Sn layers in these sandwich structures corresponded to the $Au_{20}Sn$ binary eutectic. The microstructures of the $Au_{20}Sn$ solder on the Cu and Ni substrates could be controlled by using different bonding conditions. When the bonding condition was 290.degree. for 2 min, the microstructure of $Au_{20}Sn$/Cu and $Au_{20}Sn$/Ni was a two-phase (Au_5Sn and AuSn) eutectic microstructure. When the bonding condition was 240.degree. for 2 min, the AuSn/Au_5Sn/Cu and AuSn/Au_5Sn/Ni layered microstructure formed. After bonding, the $Au_{20}Sn$/Cu and $Au_{20}Sn$/Ni diffusion couples were subjected to aging at 240.degree. The thermal stability of $Au_{20}Sn$/Ni was better than that of $Au_{20}Sn$/Cu. Moreover, less Ni was consumed compared to that of Cu. This indicates that Ni is a more effective diffusion barrier material for the $Au_{20}Sn$ solder.

8 Nanotechnology

8.1 Gold Nanoparticles are Shaped for Effect

A review. Noble-metal nanoparticles have become the basis for a new class of optical nanosensors, and have other applications as well. J Hafnor, from Rice University, Houston, TX, USA, *Laser Focus World* 2006, **42(4)**, 99. Au nanoparticles, for instance, with plasmon-resonant absorption in the near-IR can be used to photothermally destroy cancerous tumors in mice. The resonances of noble-metal nanoparticles depend on their geometry, nanoshells, nanorods, or even nanocages, can be created to achieve specific results. For many Au and Ag nanoshells, nanorods and nanocages, a key feature is that their resonances are tunable, which enables one to set the localized surface plasmon resonance at a laser wavelength or spectral region that matches a particular application.

8.2 Stabilizer-Free Nanosized Gold Sols

The paper describes a convenient, rapid, and reproducible method for the synthesis of stable dispersions of uniform Au nanoparticles at ambient temperatures by mixing aqueous solns. of tetrachloroauric acid and iso-ascorbic acid. D Andreescu, T Sau, G Kumar, V Dan from the Center for Advanced Materials Processing, Clarkson University, Potsdam USA SO *Journal of Colloid and Interface Science* 2006, **298(2)**, 742. The influence of the experimental conditions on the size of the Au particles and the stability of the final sols was monitored by dynamic light scattering and UV-visible spectrophotometry. The size of the resulting nanoparticles is affected by the concentration and the pH of Au solution, while the stability of the electrostatically stabilized final sols is strongly dependent on the excess of reductant in the system, the ionic strength, and the temperature of the precipitation. Since the precipitation process does not require the addn. of a dispersing agent, the surface of the resulting Au nanoparticles can be easily functionalized to make them suitable for applications in medicine, biol., and catalysis.

8.3 Influence of pH on Preparation of Colloidal Gold

The color and the particle size of colloidal gold were influenced by different pH values. J Liang, X He, X Xiong, X Zhang, from the Cong CS General Research Institute for Nonferrous Metals, GRIKIN Advanced Materials, Co., Ltd, Beijing, Peop. Rep. China, Xiyou Jinshu 2005, **29(4)**, 468. Colloidal gold was prepared with sodium citrate by controlling the pH of the solution The maximum of absorption and its peak width were obtained from UV/visible absorption spectrophotometry. The diameter and its distribution were measured by transmission electron microscopy (TEM). Then the results were compared and analyzed. The result shows that with the decrease of the pH, the particle size increases and the color of colloidal gold is changed (red-blue-black).

9 Refining

9.1 Abatement of Mercury Pollution in the Small-Scale Gold Mining Industry: Restructuring the Policy and Research Agendas

This paper critiques contemporary research and policy approaches taken toward the Analysis and abatement of mercury pollution in the small-scale gold mining sector. G Hilson from the School of City and Regional Planning, Cardiff University, Wales, UK, *Science of the Total Environment* 2006, **362(1-3)**, 1. Unmonitored releases of mercury from gold amalgamation have caused considerable environmental contamination and human health complications in rural reaches of sub-Saharan Africa, Latin America and Asia. While these problems have caught the attention of the scientific community over the past 15-20 years, the research that has since been undertaken

has failed to identify appropriate mitigation measures, and has done little to advance understanding of why contamination persists. Moreover, the strategies used to educate operators about the impacts of acute mercury exposure, and the technologies implemented to prevent further pollution, have been marginally effective at best. The mercury pollution problem will not be resolved until governments and donor agencies commit to carrying out research aimed at improving understanding of the dynamics of small scale gold mining communities. Acquisition of this knowledge is the key to designing and implementing appropriate support and abatement measures.

9.2 A Combination Sorption-Flotation Technology for Gold Recovery from Cyanide Solutions and Pulps

A viable flow sheet of the sorption-flotation technol. for gold recovery from low-grade ores and concentrations using powered activated carbon modified by organic compounds as the sorbent-bearer has been developed. N Dementyeva from the Irkutsk Scientific Research Institute of Precious and Rare Metals and Diamonds (OAO 'Irgiredmet'), Irkutsk, Russia, *Publications of the Australasian Institute of Mining and Metallurgy* 2005, 5/2005 (Centenary of Flotation Symposium, 2005, 947). The powd. activated carbon, with high kinetic ability and sufficient specific area, was selected as the all-purpose gold cyanide complex-bearing sorbent which is active during flotation. To improve carbon adsorption capacity and to provide the required floatability its porous structure was filled with a quaternary ammonium compd. which can ext. gold cyanide complexes and render addnl. flotation properties to the carbon. To optimize the process and to simplify the layout, adsorption and flotation processes were carried out simultaneously in a mech. flotation cell. The proposed technol. was used for extended and pilot-plant tests of sorption-flotation gold recovery from 0.6 g/t Au final tailings and 2.0 g/t Au gravity tailings. The extended tests were carried out on Taseevskaya (Chita Region) flotation tailings, whereas pilot-plant tests were conducted on Kommunarovskaya (Krasnoyarsk Region) gravity tailings passing to cyanidation, followed by processing with filtration technol. Addnl. gold recovery from Taseevskaya final flotation tailings was 50.8%. Gold recovery from Kommunarovskaya final gravity tailings was 92.5% cent. Compared to the complete sludge process conventionally used at the plant, gold recovery was increased by 7.5% due to lower gold losses in the liquid phase and conversion of the refractory non-cyanided metal into a carbon concentration. The experimental results of gold adsorption onto powd. activated carbon modified with quaternary ammonium compds. (sorbent-bearer) as well as sorbent-bearer flotation with various collectors from cyanide solns. and pulps are presented.

9.3 Method for Recovering Gold from Gold Concentrate by Acid Thiourea Process

This Patent from S Kim, H Lee, J Oh from the Korea Institute of Science and Technology, S. Korea, PATENT No, KR 2004032299, A, April 2004 describes a method for recovering gold from gold concentration by acid thiourea process is provided to leach gold from an acid thiourea aqueous solution environmentally and efficiently by using sulfuric acid to adjust pH, thiourea as a leaching agent and air externally injected along with iron ions as an oxidizing agent. The method comprises the steps of polishing gold concentration; adding sulfuric acid as an acidity adjusting agent and thiourea as a leaching agent to an aqueous solution contg. the polished gold concentration; and leaching gold from the gold concentration contained in an acid thiourea aqueous solution using air injected from the outside along with iron ions dissolved from the gold concentration, wherein the gold concentration in the polishing step has a grain size corresponding to a sieve size of 400 meshes or less, wherein an ore solution of the gold concentration has a concentration of 5 to 15 g/L, wherein the sulfuric acid has a concentration of 1 to 3 wt.%, wherein the thiourea has a concentration of 3 to 6 wt.%, wherein the air along with the iron ions dissolved from the gold concentration are injected into the solution in a flow rate of 100 to 200 mL/min in the leaching step, wherein the leaching step is performed by agitating the solution to an agitation speed of 300 to 400 rpm, and wherein the leaching step is performed at a reaction temperature of 20 to 30.degree.C for 3 to 4 h.

9.4 Process for Gold Extraction from Low-Grade Ores and Anthropogenic Wastes

Forms of occurrence of Au and Ag minerals in low-grade gold ores, which are almost always As-rich sulfide type, are discussed. Intermetallic compds. (IMC) and organometallic compds. (OMC) occur as trace impurities in sulfides (pyrite and arsenopyrite) and comprise a valuable component of sulfide-arsenide ores. A Kunbazarov, S Espenbetova, M Zhainazarova, from the Kyzylordinskii Gos. Univ. im. Korkyt Ata, Kyzyl-orda, Kazakhstan, *Kompleksnoe Ispol'zovanie Mineral'nogo Syr'ya* 2005, **(2)**, 51. Possible forms of occurrence of Au and Ag as trace impurities (TIA) in sulfide minerals are given. A coeff. of Au (or Ag) extn. by cyanation is Kextn = [1- (XIMc + XTIA + XOMC)], where XIMc, XTIA, and XOMC are coeffs. corresponding to the relative quantity of Au (or Ag) not extd. during cyanation. Calcn. of Kextn for the Zarmitan and Sayak-4 deposits, for which XIMc, XTIA, and XOMC can be reasonably estd., indicates that only 30.0% of Au is extracted from the As-rich ore concentrations. Increase in the extn. of Au and other valuable components can be achieved by paying more attention to the processing of low-grade ores and beneficiation and metallurgical wastes and also by including carbon flotation in the processing procedure. Froth flotation with the use of coal-oil coagulants together with Au-As ores

can be used to process wastes from beneficiation plants, dusts and slags in metallurgical products, fine dusts from jewelry manufacture etc.

9.5 Use of Activated Carbon Prepared from Agricultural Waste In the Separation of Gold from Industrial Wastewaters

Gold solns. with concentration of 100 ppm or less are commonly encountered in gold-using industries such as electronics, jewelery and electro-plating. M Soleimani, T Kaghazchi from the Department of Chemical Engineering, Amirkabir University, Iran, Amirkabir 2005, Volume Date 2004-2005, **15(60-3)**, 139. Conventional methods such as direct chem. precipitation. or plating out of gold from these dil. solns. are tedious and economically impractical. In most com. separation processes, gold is sepd. using activated carbon as an adsorbent. The main advantages of activated carbon are its high selectivity towards gold, its ease of elution and its large particle size. In this work, recovery of gold from electro-plating wastewaters using activated carbon was investigated. The required activated carbon was prepd. from hard shell of apricot stones by chem. activation method. The effect of several parameters such as concentration and particle size of activated carbon, pH and agitation speed of mixing on the gold recovery was studied. Adsorption tests for the effects of these factors were designed with Taguchi method. Experimental results showed that the concentration of activated carbon plays a very important role in the adsorption of gold on activated carbon, although agitation speed on mixing in the range studied does not have considerable effect on adsorption of gold. Under the optimum operating conditions, 98.15% of gold was adsorbed on activated carbon. It was found that the recovery efficiency of gold using activated carbon produced from apricot stones was higher in comparison with other imported industrial activated carbons.

9.6 A New Extraction Process of Carbonaceous Refractory Gold Concentrate

A hydrometallurgical process for a carbonaceous refractory gold concentration at ambient temperature and pressure was presented and includes grinding-leaching, intensified alk. leaching, thiosulfate leaching and cementation by zinc powder. Y Meng from the Institute of Metal Research, Chinese Academy of Sciences, Shenyang, Peop. Rep. China, *Transactions of Nonferrous Metals Society of China*, 2005, **15(5)**, 1178. The grinding-leaching and intensified alk. leaching process result in the selective oxidation of arsenopyrite and pyrite. The oxidation ratio of As is 96.6% and is 46.7% for S. The total consumption of NaOH in alk. leaching is only 28% of that theor. calculated under the conditions of full oxidation for the same amt. of arsenopyrite and pyrite transforming into arsenate and sulfate, and 83.6% of the gold is synchro-dissoluted by thiosulfate self-generated during the pretreatment. Since the carbonaceous matter in the concentration possesses a strong capability of preg robbing, the cyanidation process is not suitable for gold extn. after pretreatment. However, the gold leaching rate by thiosulfate leaching for 24 h is increased to 91.7% from 0-3.2% by ultra-fine grinding without the pretreatment. The recovery of gold by zinc cementation is .ltoreq.99.6%. Due to the thiosulfate self-generated during alk. leaching, the reagent addn. in thiosulfate leaching afterwards is lower than the normal value.

9.7 Overview of Gold Processing Techniques Around the World

A review. Between 1989 and 2004, the estd. annual global gold production increased by 47% from 1,677 t (53.9 million oz) to just above 2,464 t (79.2 million oz). J Marsden, from the Technology & Product Development, Phelps Dodge Mining Company, Phoenix, USA, *Minerals & Metallurgical Processing* 2006, **23(3)**, 121. During this time-frame, gold production methods shifted to reflect the widespread adoption of new process technol. that emerged in the 1980s, including heap leaching, carbon adsorption and whole-ore refractory treatment processes. Based on production ests., the distribution of gold production processes in use around the world are presented and discussed in this paper. The changes in process techniques that occurred between 1989 and 2004 are reviewed based on gold production ests. published in 1992 and 2006. This review is intended to be a general, high-level overview of gold-production technology distribution. More detailed and in-depth analyses are available in the referenced literature.

10 General

10.1 Dealkalization of a Glass Surface Before its Decoration by Bright Gold

The efficiency of glass surface dealkalization by products of decomposition of ammonium peroxodisulfate and ammonium sulfate, as well as by leaching in solution of sulfuric acid and by washing in detergent solution, was evaluated. L Rybarikova, H Hradecka, J Kochankova from the Ustav Skla a Keramiky, VSCHT Praha, Prague, Czech Rep, *Sklar a Keramik* 2005, **55(9)**, 221. Products of decomposition of ammonium peroxodisulfate and ammonium sulfate proved the highest efficiency, whereas the efficiency of the treatment by leaching in acid solution and by washing in detergent solution was low. The efficiency of dealkalization by ammonium peroxidisulfate used before decoration by bright gold was comparable with treatment by ammonium sulfate. From environmental point of view, using of the ammonium sulfate seems to be more suitable for dealkalization under operating conditions.